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14. ABSTRACT

The U.S. Navy?s use of tactical mid-frequency active sonar has been linked to marine mammal strandings and fatalities [Evans and England, 2001]. These events have generated legal challenges to the Navy?s peacetime use of mid-frequency sonar, and have limited the Navy?s at-sea anti-submarine warfare training time. Beaked whales may be particularly sensitive to mid-frequency sonar. A mobile, persistent surveillance system that could detect, classify and localize beaked whales will help resolve the conflict between the Navy?s need for realistic training of mid-frequency sonar operators and the Navy?s desire to protect marine mammal populations worldwide. Underwater gliders equipped with appropriate acoustic sensors, processing, and detection systems may offer a partial solution to the problem. The Acoustic Seaglider (ASG) from the Applied Physics Laboratory of the University of Washington (APL-UW) is one such platform. An ASG can travel about 20 km/day through the water for a period of weeks to months, dive from the surface to 1000 m and back in a few hours, and use two-way satellite (Iridium) telemetry for data and command transfer. This makes it potentially highly useful for mitigating impacts of Navy operations on marine mammals.

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Automatic Detection of Beaked Whales from Acoustic Seagliders

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LONG-TERM GOALS

The U.S. Navy's use of tactical mid-frequency active sonar has been linked to marine mammal strandings and fatalities [Evans and England, 2001]. These events have generated legal challenges to the Navy's peacetime use of mid-frequency sonar, and have limited the Navy's at-sea anti-submarine warfare training time. Beaked whales may be particularly sensitive to mid-frequency sonar. A mobile, persistent surveillance system that could detect, classify and localize beaked whales will help resolve the conflict between the Navy's need for realistic training of mid-frequency sonar operators and the Navy's desire to protect marine mammal populations worldwide. Underwater gliders equipped with appropriate acoustic sensors, processing, and detection systems may offer a partial solution to the problem. The Acoustic Seaglider (ASG) from the Applied Physics Laboratory of the University of Washington (APL-UW) is one such platform. An ASG can travel about 20 km/day through the water for a period of weeks to months, dive from the surface to 1000 m and back in a few hours, and use two-way satellite (Iridium) telemetry for data and command transfer. This makes it potentially highly useful for mitigating impacts of Navy operations on marine mammals.

OBJECTIVES

The objective of this effort is to develop techniques for detection and classification of beaked whale sounds for the ASG. Because any methods developed must run in the operational environment of the ASG, they must (1) have a low average computational cost because of the limited processing power and battery life of the ASG, (2) be coded in such as way as to use the software interfaces available in the ASG's computing environment, and (3) run using the potentially limited numerical computing environment of the ASG, which may not include floating-point calculations.

APPROACH

A postdoc will be hired to work on this project. He or she will develop algorithms for the detection of beaked whale clicks and for distinguishing these clicks from other marine sounds (including other marine mammal clicks), test these algorithms, implement one or more for the computing environment of the ASG, and perform field tests.

WORK COMPLETED

Not a lot of work has been completed yet because the funding for this project became available at Oregon State only last month, and I have been tied up since then with presenting a conference and then annual vacation. However, I and a fellow researcher, Holger Klinck, have developed an algorithm

known as the energy ratio mapping approach (ERMA) for detection of beaked whale clicks. It relies on calculating the ratio of two spectral bands that provide the optimum discrimination for distinguishing beaked whale clicks from other marine sounds. Because it is based on two spectral bands, its computational cost can be made quite low with two low-order IIR filters.

RESULTS

The algorithm described above has been tested on small sample data sets. Testing on larger data sets awaits the hiring of the postdoc.

IMPACT/APPLICATIONS

It is hoped that a "beaked whale Seaglider" will be useful for the conservation of cetaceans by revealing their presence before and during Navy operations, thus allowing for the use of mitigation measures to prevent harm to them. It is also hoped that ASGs equipped with the detection technology developed here will be more broadly useful, perhaps for monitoring marine mammal population changes, studies of the seasonal distribution of marine species, marine mammal behavioral observation, and other applications that we have not yet anticipated.

RELATED PROJECTS

We are closely collaborating with the project "Acoustic Seaglider for Beaked Whale Detection", with P.I. Neil Bogue of the University of Washington. Dr. Bogue's group is (1) developing and testing a new processor architecture for the ASG, (2) developing and testing an associated new acoustic recording system for the ASG, (3) leading the fieldwork to test deployments of the "beaked whale Seaglider". We are primarily developing algorithms and their software implementations for detecting beaked whales from the ASG.

REFERENCES

Evans, D.L. and England, G.R. 2001. Joint Interim Report Bahamas Marine Mammal Stranding Event 15-16 March 2000. Department of the Navy and Department of Commerce (NOAA).